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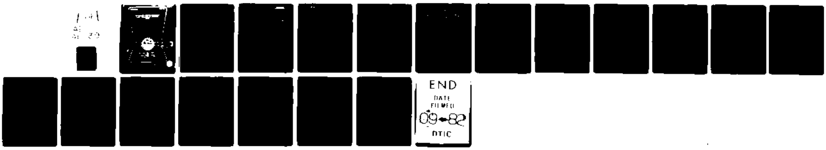

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MAP INTERPRETATION FOR LOW-ALTITUDE FLIGHT: EVALUATION OF A PROTOTYPE COURSE

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A two-part map interpretation and terrain analysis course (MITAC-II) was developed to improve the low-altitude visual orientation skills of fixed-wing pilots. Part 1, a lecture, explains and illustrates how real-world features are selected for map portrayal and how their visual significance is affected by low-altitude operations. Part 2 is composed of nine dynamic exercises designed to give practice, drill, and self-evaluation in the map interpretation principles presented in the lecture. An experimental evaluation of

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the course indicated that it provided a significant improvement in the location of tactical targets, but not in the identification of terrain targets. The latter finding may have been due to artifacts in the testing situation. Participants stated that low-altitude orientation skills were improved as a result of the course. It was recommended that the full MITAC-II course be implemented early in flight training.

FOREWORD

This research and development was performed under exploratory development task area ZF63-521-080 (USMC Manpower and Training Technology) and the sponsorship of Headquarters, U. S. Marine Corps (Code TDA). This is the second and final report relating to an experimental map interpretation and terrain analysis course (MITAC-II) for fixed-wing aviators. The first report, NPRDC Techical Report 82-43, described the development of MITAC-II, the system used for the dynamic exercises, and the evaluation of the proposed training program. This report describes an experimental evaluation of the final version of MITAC-II.

Appreciation is expressed to the subject matter experts from the Marine Aviation Weapons and Tactics Squadron-1, Marine Corps Air Station, Yuma, Arizona, particularly Major James Wojtasek, and from VF-124, Naval Air Station, Miramar, San Diego, California, particularly Lieutenant Commander James Dodge, for their support in this effort. Appreciation is also expressed to the personnel of the Third Marine Aircraft Wing, El Toro, California, who served as test subjects.

JAMES F. KELLY, JR.
Commanding Officer

JAMES J. REGAN
Technical Director

SUMMARY

Problem and Background

Fixed-wing aviators report having serious problems locating targets and checkpoints during low-altitude flights. Part of this problem is due to geographic disorientation that can occur when aviators fly at low altitudes and high speeds. Current flight training does not adequately provide the skills needed for geographic orientation. These skills are even more important in tactical environments where aviators conduct operations over unfamiliar terrain. Therefore, to improve the ability of aircrews to maintain low-altitude geographic orientation regardless of environment and task load, information obtained from subject matter experts (SMEs) was used as a basis for developing a two-part map interpretation and terrain analysis course (MITAC-II). Part I, a five-section illustrated lecture, explained how real-world features are selected for portrayal on Joint Operations Graphic (JOG) charts and how their visual significance is affected by low-altitude operations. Part II was composed of nine dynamic exercises (based on filmed flights) in which the student applied the principles of map interpretation from the lecture to the problem of visual orientation. Results of formative evaluation of the initial course content and media, which was conducted with Navy and Marine Corps aviator SMEs, showed that MITAC-II provided valuable training.

Purpose

The purpose of the effort described herein was to evaluate the final version of MITAC-II.

Approach

MITAC-II was revised, based on results of the initial evaluation, and evaluated experimentally, using 54 Marine Corps aviators randomly assigned to three groups. All groups were familiarized with the simulator and response measures. Group I received no additional training, Group II received only the illustrated lecture portion of MITAC-II, and Group III received the entire MITAC-II. All three groups were tested on their ability to identify both tactical and terrain targets presented during a filmed flight.

Results

Significant differences in ability to identify tactical targets were found among the three groups. The performance of Group III, who had received both the illustrated lecture and the dynamic exercises, was significantly better than that of Group I, who had no additional training, and Group II, who had received only the illustrated lecture. Group II performance was not significantly better than that of Group I.

Significant differences were not found among the groups in ability to identify terrain targets, but there are several artifacts that may have limited these differences. Although the analysis did not show significance, the trend was in the anticipated direction.

Conclusions

The combination of the illustrated lecture and dynamic exercises is an effective means of improving the capability of pilots and naval flight officers to locate tactical targets. Questionnaire responses from the participants were positive toward the objectives and content of the course. They also stated the course would contribute to

their low-altitude orientation skills. Most participants indicated the course should be implemented early in flight training.

Recommendations

It is recommended that, for maximum effectiveness, the full MITAC-II course be given. It is further recommended that the course be given during the early part of aviator training once the aviators have received their wings by completing undergraduate flight training. It is suggested that the responsibility of this action be given to Headquarters, U.S. Marine Corps (Code TDA).

CONTENTS

INTRODUCTION

Problem

Pilots and naval flight officers (NFOs) report that locating targets and checkpoints during low-altitude flights is a serious problem. The problem is often attributed to geographic disorientation, which can be traced to one or a combination of the following difficulties: (1) failure to recognize correctly, on the ground, the feature portrayed on the map, (2) misidentifying a ground feature as being portrayed on the map, (3) inability to visually acquire the target or checkpoint because of masking, (4) failure to evaluate the visual significance of portrayed features, or (5) inability to relate the shape and arrangement of the contour lines to landforms. The consequent disorientation is unique to aviators who are required to fly at combinations of low altitudes and high speeds.

Current flight training does not emphasize map interpretation because it is assumed that aviators have acquired basic map interpretation skills prior to entering the service. Most aviators do have some map reading skills; that is, they can read the legend and match the symbols in the legend with the same symbols portrayed in the body of the map. The skills that do exist have generally been learned from standard road maps and thematic diagrams. Few aviators, however, have learned to interpret relief and to integrate this information with other features to develop a total mental image of the portrayed area. Map reading and map interpretation represent two entirely different skill levels. Current flight training does not address the latter.

Background

Current Flight Training

Fixed-wing low-altitude flights are flown at 200 feet above ground level (AGL) at speeds approaching 500 knots. The combination of high speed and low altitude frequently results in disorientaiton and an inability to locate or recognize checkpoints. The increase in the dynamic geometry of the environment requires the aviator to recognize features that are constantly changing their visual shape as a function of perspective.

Initial flight training, conducted at Pensacola, Florida, focuses on aircraft handling and related tasks. Emphasis is on high-altitude operations. Flights are planned using tactical pilotage charts (TPC 1:500,000) and are flown over designated air corridors. One element of mission planning is the selection of turn and checkpoints. Because these operations are conducted over a limited geographical area, information about visually significant features is often passed along from one group of students to the next, and these features are incorporated into the flight plans.

The majority of the turn and checkpoints used in the flight training are cultural features and their locations along the course are carefully calculated for time and distance. Although a map is used to plan the mission, almost no map interpretation skills are required of the aviator; the planning is systematic and mechanical. The available air corridors are over a flat coastal plain that provides a limited variety of terrains. Consequently, there is little need to use the map as an orientation tool.

Aviators also receive their first introduction to low-altitude flights during this part of the flight training. Emphasis is on becoming comfortable with flights at these altitudes. The primary difference in using a map to plan for low-altitude flights is the evaluation of portrayed vertical features as possible check or turnpoints. With no

significant relief in the area, the aviators are limited to hydrographic and cultural detail, with emphasis on vertical features such as towers or obstructions. Again, because of the school environment, word quickly spreads regarding those symbolized features that are visually significant, and the full potential of map use is not realized.

After completing basic flight school at Pensacola, pilots receive additional instruction unique to their aircraft type. Primary emphasis again is on aircraft handling and communications and relatively little time is spent with map usage. This instruction also covers low-altitude navigation and orientation. The low-altitude training is usually included as segments of longer flight missions. Like the initial training, these segments are confined to specific corridors with relatively little topographic diversity. The number of actual low-altitude segments is limited, and they are conducted over areas familiar to the pilot. Consequently, map associations tend to fall in place because of this prior exposure to the landscape. Known checkpoints, along with computed time and distance information, help the aviator to maintain his orientation. In combat situations, however, the aviator may encounter completely foreign topographic environments. He may not be prepared to interpret the landscape from his map. He may be further handicapped by having outdated charts, or charts produced by foreign cartographers. The features portrayed on the map and the ways in which they are symbolized may differ from those the aviator was exposed to during his training. The one symbol that remains uniform, however, is the contour line. Contour depictions are the same, regardless of the map's origin, and the landforms they represent are the most stable feature portrayed on the map.

If the aviator can interpret the terrain, he will be better prepared to complete his mission successfully. Map skills as they are currently taught, however, do not sufficiently prepare the aviator for orientation tasks requiring contour information. The traditional approach to instruction in map reading uses drawings of maps matched perfectly to hypothetical landforms and cultural landscapes. This one-to-one association is rare in actual practice and gives the students a false sense of competence. When confronted with an actual map interpretation problem, the aviator is unable to conceptualize the landscape represented by the map display. He compensates, therefore, by becoming highly proficient in interpreting cultural features, which are intrinsically less reliable. The aviator needs to understand the reasons for this because they will affect his orientation task.

Development of MITAC-I for Rotary-wing Community

In 1975, a new approach to map interpretation and terrain analysis was developed as the result of a research effort initiated by the Army Research Institute. This effort was directed toward improving the map interpretation skills needed for nap-of-the-earth (NOE) flights by rotary-wing aviators.[1]

An illustrated lecture was developed that described the design elements used in creating 1:50,000-scale topographic maps. The lecture used 35mm slides of real-world scenes to illustrate the design elements; the slides were synchronized to taped narrations. The resultant map interpretation and terrain analysis course (now known as MITAC-I) consisted of a series of modules covering the map portrayal of hydrographic features, vegetation, transportation lines, buildings, and miscellaneous cultural features. A short additional module, entitled contour interpretation, was composed of five static exercises

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[1] McGrath, J. J., & Foster, E. A. Development of a system of aircrew training in nap-of-the-earth navigation. Santa Barbara, CA: Anacapa Sciences, Inc., January 1975.

in which the students analyzed real-world scenes and their map portrayal by interrelating the principles learned from the earlier lecture modules in addition to using contour analysis. The lecture modules were followed by a series of 16mm filmed exercises that provided drill and practice on the map interpretation concepts presented in the lecture. The exercises exposed subjects to 1:50,000-scale topographic, pictographic, and air movement data maps.

MITAC-I was evaluated by the Army in a series of in-flight tests. Results showed that checkpoint acquisition and time to complete the mission were improved as a result of the MITAC-I training. Thus, it was shown that skills transferred to actual flight situations. The course was subsequently modified and adapted by the Navy Personnel Research and Development Center (NAVPERSRANDCEN) to USMC helicopter training.[2] It was subsequently adopted into the Navy advanced helicopter syllabus at the Training Command, HT-18, Whiting Field, Florida. It is also used by the Navy search and rescue community.

The rotary-wing MITAC-I, now under procurement, was developed as a prototype; it was not intended to be a complete course, but only a demonstration of a training method. Nonetheless, the training is highly effective. There is, however, an opportunity to further improve performance by increasing the scope of the course to include lecture information on contour analysis as well as a segment on the principles of cartography that are generic to all maps.

Development of MITAC-II for the Fixed-wing Community

The effectiveness of the rotary-wing MITAC-I program suggested the possibility of similar training for the fixed-wing community. Although the basic principles of map interpretation are common to all maps, the fixed-wing environment presents unique problems that require different information and emphasis.

Weapons and tactics instructors (WTIs) from Marine Aviation Weapons Training Squadron-One (MAWTS-I), Marine Corps Air Station, Yuma, Arizona were interviewed to identify the requirements of aircrews involved in low-altitude operations and the training procedures currently used. Data obtained were used as the baseline for developing the low-altitude orientation training program. This program, which is called MITAC-II to distinguish it from the previous rotary-wing course, consists of an illustrated lecture and dynamic exercises.

The lecture, which is presented in a dual-slide and tape format, is composed of five sections, beginning with a general introduction and followed by information on four topic areas (topography, hydrography, vegetation, and cultural features). It concludes with a series of static orientation exercises. The lecture is illustrated with 350 real-world scenes (35mm slides), which were selected from the Boeing Film Imagery Library. The scenes, each of which is matched with a slide of its map portrayal, provide visual examples of the various features discussed in the taped lecture narrations.

The 70-mm film imagery used for the dynamic exercises was obtained from the Boeing Film Library. Ten mission films were selected, which had been developed from imagery obtained during programs supporting Joint Task Force Two (JTF-2), a joint-service test and evaluation effort conducted by the Joint Chiefs of Staff between 1965

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[2]NAVPERSRANDCEN memorandum 306:OAL:11p of 13 Apr 1978 to Headquarters, U.S. Marine Corps (Code APW); subj: USMC air navigation training: interim recommendations for

and 1968 to evaluate all phases of the low-altitude mission, and the Combat Air Support Target Acquisition (Project SEEKVAL) during 1972-1974 test activities, which were administered by the Air Force Test and Evaluation Command (AFTEC) to evaluate target acquisition system concepts using direct or aided vision.

A feasibility demonstration of MITAC-II was conducted with 15 SMEs participating. Eleven were WTIs from MAWTS-1, and the other four were advanced crew-training instructors from Fighter Squadron (FITRON) 124, Naval Air Station (NAS), Miramar, San Diego, California. Six of the participants were pilots, six were radar intercept officers, one was an aerial observer, and two were bombardier/navigators. They represented the F-4, RF-4, A-4, A-6, OV-10, and F-14 aircraft communities.

The demonstration was conducted at the Boeing Space Center in Kent, Washington. After participants had been given a short introduction and had completed a demographics questionnaire, the illustrated lecture was presented. As each module of the lecture was completed, it was critiqued by the participants and test personnel. All comments were recorded.

The dynamic exercises were given in the Boeing combat aircraft mission simulator. The simulator is an integrated avionics simulation facility composed of several hardware elements with attendant software modules. Various elements and modules are combined, based on mission requirements, to provide the needed crew/cockpit interfaces. The elements used in the course consisted of a multimission simulator lab (MMS) and the Varian 75 computers located in the visual flight simulation lab (VFS).

The demonstration was evaluated through responses to the demographic questionnaire and questionnaires administered concerning the value of the illustrated lecture and the dynamic (simulator) exercises. Responses indicated that the MITAC-II concept and approach to low-altitude visual orientation training is progressive and advantageous. The format and content of the illustrated lecture were considered informative and were approved by the SMEs. The simulation, using the wide-angle visual system, was effective in providing the necessary environment to integrate the training content with operational tasks. The two components, acquisition of new skills in map interpretation and terrain analysis from the illustrated lecture and use of the simulator to exercise the new skills in real-time, complemented each other well.

Development of MITAC-II, the software and design of the feasibility demonstration, and the demonstration itself are described in detail in the first report issued on navigation training methods for low-altitude flight.[3]

Purpose

The purpose of the effort described herein was to evaluate the final version of MITAC-II.

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[3]Qualy, J., Jahns, D. W., Gilmour, J. D., & Paulson, D. Navigation training methods for low-altitude flight (NPRDC TR 82-43). San Diego: Navy Personnel Research and Development Center, May 1982.

APPROACH

Revision of Materials

Results of the SME evaluation were used to refine the course prior to final testing and evaluation. The lecture sections were carefully reviewed and special attention was directed toward any slides or taped narrations that had elicited evaluator comments. A limited number of slides with poor film quality were replaced. Also, slides were developed for the landform portion of the terrain analysis section that had not been completed in time for the SME evaluation.

All of the map slides were rephotographed with a close-up lens so that the viewer could see more detail. The graphic slides were also redone so that the format and style was consistent throughout the lecture.

Lecture material that was ambiguous was clarified, and conclusions were restated as guiding principles rather than rules. The vegetation section was scaled down and reorganized, with emphasis on regional variation in the portrayal of vegetation features. The section on cultural features was lengthened slightly to include airfields, and a segment was developed that discussed the use of cultural features in combination with cues from the natural landscape.

A new exercise was developed to replace one in which there were major discrepancies (due to changes over time) between the cultural features seen in the film and those shown on the only available map.

Evaluation of Training Course

Subjects

NAVPERSRANDCEN requested 54 subjects from the Third Marine Aircraft Wing for use in evaluating the completed MITAC-II course. The subjects were to have a maximum of 600 hours military flight time in type (i.e., flight time in their primary assigned aircraft). Subjects, which included aerial reconnaissance officers (AROs), radar intercept officers (RIOs), and bombardier navigators (BNs), were randomly assigned to three groups of 18 subjects each. Group I, which served as a control group, was familiarized with the simulator and the response measures that would be used, and then given the performance test. Group II was given the illustrated lecture and the same familiarization as Group I and then given the performance test. Group III was given the complete MITAC-II course (i.e., both the illustrated lecture and the dynamic exercises) and the same familiarization as Groups I and II, and then given the performance test.

Performance Test

The performance test was given in the same simulator that was used for the dynamic exercises. Three student stations, each with its own digital clock, radio magnetic indicator (RMI), target acquisition switch, and map lamp, were located in front of the viewing screen.

The performance test was designed to provide both direct and indirect measures. The first, an enroute orientation task, required the subject to indicate which of three similar features, clustered in the same general area, was located directly under the flight path. Each feature was circled on the map and a "ready-mark," or warning tone, was presented

over the headset to indicate that the flight was approaching a cluster of features. There were 12 clusters based on different terrain features.

The second task required the subject to locate and identify eight tactical targets (e.g., tanks, surface-to-air missiles, bridges). The targets were plotted on the map and aerial photographs and briefings on all targets were provided before the flight. The subjects pushed the target acquisition switch as soon as they positively identified each target and again when they passed directly over it. This task was previously found to be effective as an indirect measure of orientation during the JTF-2 and SEEKVAL experiments.

RESULTS

The summary results for the terrain orientation task are presented in Table 1. The values are proportions of correct choices. The arcsin transformation[4] was applied to the proportions for individual subjects, and a one-way analysis of variance (ANOVA) was used to test for differences among groups. The resultant F value of 0.29 (df = 2,33) is not significant at the .05 level. It should be noted that, even though these groups did not differ significantly on the terrain orientation task, the means tended to increase from Group I to Group II to Group III.

Table 1

Mean Percentage Correct Responses
on Terrain Orientation Task

	Terrain Cluster Number												
Group	1	2	3	4	5	6	7	8	9	10	11	12	All
I	17	17	28	83	83	89	78	39	78	72	72	72	61
II	28	39	67	67	94	94	94	17	61	89	72	67	62
III	61	33	39	72	94	89	100	56	61	72	94	44	72

The summary results for the target acquisition task are presented in Table 2. The measure used for each tactical target was based on the flight time between target acquisition and arrival at the target. These times were adjusted for differences in the availability of different targets by dividing the actual recorded time by the best (longest) possible time for acquiring that target. Thus, good performance is indicated by scores near 1.00.

[4]Winer, B. J. Statistical Principles in Experimental Design, New York: McGraw-Hill, 1962.

Table 2

Mean Ratios by Group
for Target Acquisition Task

	Target Number								
Group	1	2	3	4	5	6	7	8	All
I	11	41	23	81	35	10	23	44	34
II	10	40	27	83	49	12	19	39	35
III	20	58	35	80	59	24	29	58	45

Note. Decimal points omitted.

Result of a two-way ANOVA performed on these data indicate that the interaction is not significant, but that there are significant differences on the main effects of training method ($F = 6.95$, $df = 2,51$, $p < .01$) and of targets ($F = 67.48$, $df = 7,357$, $p < .01$). The latter result was expected as the targets were selected to be differentially accessible. The differences between training methods were further analyzed using the studentized range statistic.[4] The comparison of Group III with Group I resulted in a $q = 13.66$ ($df = 3,51$), which is significant at the .01 level. When Group III was compared to Group II, $q = 12.00$ ($df = 3.51$), which is also significant at the .01 level.

These target acquisition results provide strong indications that the complete training package (Group III) did have a positive impact on orientation skills. The results also indicate that the illustrated lecture (Group II) by itself does not contribute significantly to the acquisition of tactical targets. This latter result was not entirely unexpected as the lecture was not designed as stand-alone training. Rather, it was intended to provide information that would be applied during the exercises.

Questionnaire responses provided by the participants were very positive toward the objectives and content of the course. Many participants indicated that training of this type was new to them. A few stated that they had received similar training but could not readily indicate where it had occurred. When asked where such training should be implemented, most respondents stated it should be in the basic undergraduate flight training received in Pensacola. Many of the participants also indicated that it should be provided by operational squadrons, not only for new graduate aviators, but also as refresher training for experienced pilots. It was noted that experienced pilots initially had difficulties with the course because they were trying to use old habits that contradicted the terrain analysis emphasis of the course. Implementation of the course early in graduate flight training, it was felt, might preclude the development of inappropriate habits.

DISCUSSION

The illustrated lecture could probably be modified so as to provide more effective instruction. Many subjects indicated that more drill or practice within the lecture sections would be beneficial. At present, only one part of one lecture has such practice. If appropriate materials were available, practice and drill exercises could be added easily

to the remaining sections. It is predicted that such additions would provide a substantial improvement to the total training package.

A more elaborate revision of the lecture materials might also be warranted. The limitations of the materials may have contributed to the lack of significant differences in performance on the terrain orientation task. As noted previously, the visual materials for the course were obtained from existing sources and were originally produced to meet goals and objectives different from those of the present project. Their use permitted the project to stay within the budget, since acquisition of new aerial films and slides is costly. However, since it was difficult and, at times, impossible to find materials that fully met the objectives of the present effort, materials were often selected on a best-available basis. Similarly, there were not enough suitable materials available for the development of drill and practice exercises. Ideally, reconnaissance films and photos would have been taken with elevations, viewing angles, and features all specifically matched to the intent of each objective.

The auditory cues used to elicit choices during the terrain orientation testing may have created a serious artifact. Both observations during testing and interviews after testing indicated that many of the aviators were using the tone as a guide to where they should be on the flight. When the tone was presented, many participants who were tracking either behind or ahead of the markpoint would immediately jump to the next terrain cluster point to make a decision. In doing so, they would ignore much of their training on terrain orientation and tracking. Since there were no false clusters, the response measure had the undesirable effect of updating the subjects as to their progress along the route. A subsequent study should investigate the feasibility of using a different sort of cue or no cue at all. It should be noted that significant differences were found in the target acquisition test, which was relatively free of artifacts.

The participants also noted that a number of the markpoints dealt with map features that would rarely be used as checkpoints on a real flight. The intent of the exercise was to discourage the use of old habits and to encourage the use of skills and knowledge acquired in the course. The markpoints were selected to achieve this purpose. It might have been better to have points that met the subjects' expectations but still required the use of the new skills and knowledge. However, this would have required new films.

Choices at the 12 markpoints of the terrain orientation task differed considerably in difficulty. At some of the easier points, some of the alternative features (e.g., those very near the edge of the map) may not have functioned as effective distractors. This may have reduced the extent of differences found in student proficiency.

One additional artifact may be attributed to the aviators' prior flight experience. NAVPERSRANDCEN had attempted to obtain subjects having a maximum of 600 hours in type aircraft of military flight time (this does not include training hours). Thirty-seven subjects (69%) met this standard. However, seven had between 601 and 1000 hours; and five, between 1001 and 1500 hours (more than twice the experience level requested). The remaining five had more than 1500 hours, with three in the 2000 hours plus category and one with 3900 hours. Seven members of Group II (39%) exceeded the 600-hour limit. Because of the given variety of hours and aircraft types, it was not possible to analyze any effect that these variations may have had on the final results.

It has been suggested that the lecture portion of MITAC-II could be implemented by itself and that the squadrons could duplicate the exercise portion of the course using actual flights. To fully duplicate this training would require a two-place aircraft where the only student task would be to form map-ground associations. It would also require

that each flight be flown twice, once with the student making his own analysis, and again with the instructor giving a detailed ground track analysis. It is unlikely that there are sufficient qualified instructors for this method of training.

Additionally, it is feared that flight operations will be reduced in number in the future because of increasing fuel, maintenance, and procurement costs. Implementation of the full MITAC-II program may be a solid alternative to low-altitude flight training when flight hours are reduced. The SMEs who evaluated the draft materials indicated that they had a greater awareness of terrain features when they returned to their squadrons. Despite their high level of experience, they felt the course contributed significantly to their map interpretation skills.

There should be a systematic investigation of the equipment needed for effective training. As noted earlier, this effort was conducted at the Boeing facility in Kent, using parts of their multimission cockpit simulator, their 160° by 60° projection screen, and their Varian 75 computer for controlling the filmed exercises and tests. Alternative systems that could maintain similar resolution and field of view should be considered. The software program could be performed on a small microprocessor.

It would also be interesting to investigate the impact that dynamic displays would have within the lecture. Some comments on the static exercises following the lecture indicated that the task was rather "artificial" in that, in actual flight, one would never be presented with a single image and be required to determine the location. It would be quite costly to develop dynamic displays since it would again require new films to meet the training objectives. However, training effectiveness may outweigh these production costs.

CONCLUSIONS

1. MITAC-II is effective in improving the visual geographic orientation of pilots and NFOs and increasing their capability to locate tactical targets.

2. The two-part course, consisting of lecture and exercise, is not effective when only the lecture segments are presented.

3. Participants were very positive toward the objective and content of the course. Many participants indicated that they had not previously received similar training. Most felt that the course should be implemented early in their flight training, and that it could also serve as refresher training for expeienced pilots.

RECOMMENDATIONS

1. The full MITAC-II course, both lecture and exercises, should be implemented to ensure maximum training effectiveness. Systematic investigation should be made to determine if some other less complex and expensive equipment could be used to support MITAC-II effectively.

2. The course should be implemented during the early part of aviator training once the aviators have received their wings by completing undergraduate flight training.

3. It is recommended that the responsibility of these actions be given to Headquarters, U. S. Marine Corps (Code TDA).

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Commanding General, Third Marine Aircraft Wing
Commander in Chief U.S. Atlantic Fleet
Commander in Chief U.S. Pacific Fleet
Commander Fighter Airborne Early Warning Wing, U.S. Pacific Fleet
Commander Fighter Squadron 101
Commander Fleet Training Group, Pearl Harbor
Commander Naval Air Force, U.S. Atlantic Fleet (Code 312F)
Commander Naval Air Force, U.S. Pacific Fleet (Code 311)
Commander Naval Air Systems Command
Commander Naval Aviation Schools Command, Pensacola
Commander Naval Military Personnel Command (NMPC-013C)
Commander Naval Air Development Center
Commander Naval Ocean Systems Center (Code 033)
Commander Training Command, U.S. Atlantic Fleet
Commander Training Command, U.S. Pacific Fleet
Commanding Officer, Marine Aviation Weapons Tactics Squadron-1
Commanding Officer, Naval Education and Training Program Development Center (Technical Library) (2)
Commanding Officer, Naval Regional Medical Center, Portsmouth, VA (ATTN: Medical Library)
Commaning Officer, Naval Training Equipment Center (Technical Library)
Director, Naval Civilian Personnel Command
Director, Naval Education and Training Program Development Center Detachment, Memphis
Officer in Charge, Central Test Site for Personnel and Training Evaluation Program
President, Naval War College (Code E114)
Superintendent, Naval Postgraduate School
Commander, Army Research Institute for the Behavioral and Social Sciences, Alexandria (PERI-ASL)
Director, U.S. Army TRADOC Systems Analysis Activity, White Sands Missile Range (Library)
Chief, Army Research Institute Field Unit--USAREUR (Library)
Chief. Army Research Institute Field Unit, Fort Harrison
Chief, Army Research Institute Field Unit, Fort Rucker
Commander, Air Force Human Resources Laboratory, Brooks Air Force Base (Scientific and Technical Information Office)
Commander, Air Force Human Resources Laboratory, Lowry Air Force Base (Technical Training Branch)

Commander, Air Force Human Resources Laboratory, Williams Air Force Base (AFHRL/OT)
Commander, Air Force Human Resources Laboratory, Williams Air Force Base (CNET Liaison Office AFHRL/OTLN)
Commander, Air Force Human Resources Laboratory, Wright-Patterson Air Force Base (AFHRL/LR)
Director, Plans and Programs, Air Force Logistic Management Center, Gunter Air Force Station
Commandant Coast Guard Headquarters
Commanding Officer, U.S. Coast Guard Research and Development Center, Avery Point
Commanding Officer, U.S. Coast Guard Training Center, Alameda
Superintendent, U.S. Coast Guard Academy
Commander, 162nd Tactical Fighting Group, Tucson
Defense Technical Information Center (DDA) (12)

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